BEAM ATTACHMENT SYSTEM

The present invention relates to a beam attachment system, in particular, for long-span beams.

Beams and, in particular, long-span beams have various uses, in particular in the field of large-span structures, for the construction of buildings and engineering structures. Examples of such structures are warehouses, hypermarkets, aircraft hangars, sports centres, buildings on piles or of great height, car parks, bridges and footbridges.

FR 2 611 781 discloses a system ensuring the support and attachment of long-span beams. The attachment is carried on metal support posts, each post being provided with at least one buttress leg member articulated at its lower end on an articulation shaft integral with the corresponding post. The upper end of the buttress member is provided with a two-wing channel on which bears a corner strengthening member integral with the end of a long-span beam by means of contact members with which said corner strengthening member is provided. Thanks to this system, the vertical reaction to the weight of the beam is transferred into a buttress force on the shaft of the corresponding leg member. This force in turn creates a horizontal longitudinal stress force on the corresponding long-span beam, intended to support a structure.

The reaction of the weight of the beam transferred by buttress force to the shaft of the leg member stresses the posts to which the beams are attached, pushing them apart. This means that the buttress force exerts a moment on the posts. When seeking to increase the span of the beam, one possibility is to increase the longitudinal stress in the beam. An increase in stress in the beam leads to an increase in moment, i.e. an additional stress exerted on the posts. This increase in moment can in turn lead to a deformation of the posts such as flexural buckling or rupture when the bending strength threshold of the post is passed. Deformation of a post threatens the stability of the attachment system. With even more reason, rupture of a beam is clearly not desirable.

A need therefore exists for a beam attachment system which makes it possible to increase the span of the beam and retain the stability of the system.

A subject of the invention is a beam attachment system comprising two posts, a beam and at least one beam tie, in which the posts are stressed by the beam pushing them apart and stressed by the beam tie pulling them together.

In preferred embodiments, the invention comprises one or more of the following characteristics:

- the beam is connected to the beam tie;

- the beam and the beam tie are mounted sliding relative to each other according to a finite sliding portion;

- sleeves mounted on the beam tie delimit the finite sliding portion;

- the beam comprises at least two lateral parts between which a beam tie passage is formed;

- the beam is supported by the beam tie;

- the beam comprises several longitudinal segments;

- each of the posts is connected to the beam by means of a connecting rod, the connecting rod being articulated on the one hand on the post that it connects to the beam and on the other hand on the beam;

- one of the posts is an edge post.

Other characteristics and advantages of the invention will become apparent on reading the detailed description which follows, of the embodiments of the invention, given by way of example only and with reference to the attached drawings, which show:

- Figure 1: a diagrammatic illustration of the attachment system according to the invention;

- Figure 2: a front view and cross-section representing the upper part of a post connected to two beams by means of connecting rods;

- Figure 3: a top view of the elements represented in Figure 2;

- Figure 4: a partial front view of a beam tie fixed at the head of a post and at the level of one end of a beam;

- Figure 5: transversal cross-section of a beam, at the level of a central section of the beam;

- Figure 6: partial view and cross-section, along a longitudinal section of the beam, at the level of its central part;

- Figure 7: a front view, representing a beam intended to be mounted in the attachment system;

The invention proposes a beam attachment system comprising two posts, a beam and at least one beam tie, in which the posts are stressed by the beam pushing them apart and stressed by the beam tie pulling them together. The beam tie compensates at least in part for the stress exerted by the beam on the post. This system makes it possible to lengthen the span of the beam and to retain the stability of the system.

Figure 1 is a diagrammatic illustration of the attachment system according to the invention. The figure shows an edge post 14 as well as several posts 5a, 5b, beams 3a, 3b, 3c and beam ties 9a, 9b, 9c. The posts 5a, 5b are embedded in the

ground 4 (i.e. in the foundation) and form a metal frame intended for the attachment of the beams. The general reference number 3 designates a beam, the number 9 designates a beam tie and the number 5 designates a frame post other than an edge post. The additional reference letters a, b, c designate different sections of the frame. A beam is attached between two posts using support systems which are described below. The beam tie is an element of the system intended to resist traction. It can for example be fixed at the head of a post and be produced in the form of a cable or a tensioned shaft. The beam attachment system 1 according to the invention therefore comprises two posts 5a, 5b, a beam 3b and at least one beam tie 9b. The beam is placed under stress and the beam tie connects at least one of the posts 5a,5b, so that the two posts 5a, 5b are stressed by the beam 3b pushing them apart and stressed by the beam tie 9b pulling them together. The stress exerted by the beam tie 9b compensates at least partially for the moment exerted by a beam on the posts and moreover creates an increase in longitudinal stress in the beam. This system thus makes it possible, on the one hand, to lengthen the span of the beam and, on the other hand, to absorb part of the stress exerted on a post. It therefore also makes it possible to retain the stability of the system.

Figure 2 is a front view and cross-section representing the upper part of a post connected to two beams by means of connecting rods. The figure shows a post 5a, two beams 3a, 3b, a vertical fastening 17, two connecting rods 13a, 13b, two distribution plates 19a, 19b and two beam ties 9a, 9b. One element a of each pair of abovementioned elements a, b is situated to the left of the post 5a, the other element being situated to the right of the post. The post 5a is embedded in the ground 4 in this example and, more particularly, in the foundation. According to a variant it can be articulated on the foundation. The post 5a is connected to the beams 3a, 3b by means of a connecting rod 13a, 13b articulated on the one hand on the post 5a which it connects to a beam and on the other hand on a beam 3a, 3b. The articulation at the level of the post 5a can be produced by means of a pivot connection 14a, 14b or, as a variant, by means of a shaft. The articulation at the level of the beam can be produced by means of a support angle 18a, 18b. A corner strengthening member can then be articulated in the support angle 18a, 18b so as to form a pivot connection. For example, the corner strengthening member can be produced in the form of a distribution plate 19a, 19b. This plate fixed to a beam 3a, 3b makes it possible, on the one hand, to support this beam and, on the other hand, to distribute the reaction of the support in this beam 3. Two beam ties 9a, 9b are fixed at the head of the post 5a, to the left and to the right, respectively.

According to a variant, only one beam tie is fixed at the head of the post 5a. The same beam tie can then extend along a frame comprising several posts. Such a

structure has the advantage of distributing the stresses, as well as the absorption of these stresses, along the frame. This results in a better cohesion of the frame.

The beam ties are at least partially retracted into the beam, as described below. A fastening 17 of the two beams, at the head of the post 5a, can moreover be ensured by two fastening elements, situated on both sides of the beams. This is better described with reference to Figure 3.

Figure 3 is a top view of the elements represented in Figure 2. Each of the beams 3a, 3b comprises two lateral parts, respectively referenced in Figure 3 as 3aG, 3aD, 3bG and 3bD. The two lateral parts are assembled and connected by fixing elements 20a, 20b such as bolts. These fixing elements pass through a distribution plate 19a,19b, as represented in Figure 2. These plates are however hidden by a beam tie 9a, 9b and are therefore not visible in Figure 3. The lateral parts 3aG, 3aD, 3bG, 3bD are clamped at their head by the two fastening elements 17G, 17D, which can thus prevent the lateral buckling of the beams. Other fixing elements 16 hold the fastening elements 17 clamping the head of the beams 3a, 3b. A passage 15a, 15b is formed between two lateral parts, allowing a beam tie 9a, 9b to engage therein. The section of the half-beams can be designed so that after the assembly of the two half-beams, a passage 15a, 15b forms a channel allowing a beam tie 9a, 9b to engage therein. A beam tie 9a, 9b is thus at least partially retracted into a beam, which makes it possible to protect it, for example in case of fire. In the embodiment represented in Figure 3, two beam ties 9a, 9b are fixed at the head of the post 5a.

Figure 4 is a partial, front view of a beam tie fixed at the head of a post and at the level of one end of a beam. The figure shows a beam tie 9b, the head of a post 5a, a beam 3b as well as a tensioning element 23b of the beam tie 9b. This element 23b makes it possible to adjust the tension of the beam tie 9b, for example after the mounting of the beam 3b on the posts and of the beam tie with the beam.

Figure 5 is a transversal cross-section of a beam, at the level of a central section of the beam. This figure shows a beam 3 comprising two left and right lateral parts (or half-beams) 3G, 3D firmly connected by fixing elements 20. The figure also shows part of a post 5 and a connecting rod 13 articulated on the post 5 via a pivot connection 14 and in contact with the beam 3 at the level of a distribution plate 19 of the beam. The fixing elements 20 pass through this plate 19. The left 3G and right 3D lateral parts of the beam 3 form a passage 15 allowing a beam tie (not shown) to engage therein.

It should be noted that the beam tie passage 15 means there is much less material in the beam. In addition it allows the beam tie to be engaged inside the beam in order to support it, the passage 15 releases material and therefore lightens the beam 3. The beam 3 is thus less subject to the buckling caused by its own mass.

Moreover, the retraction of the beam tie inside the passage 15 reduces the space requirement of the beam tie and makes it possible to protect the beam tie, for example, in case of fire. If needed, a fire-retardant film can be fixed in such a manner as to close the passage 15, in order to further protect the beam tie in case of fire.

In one embodiment, the passage 15 is formed in such a manner that the beam tie supports the beam at the level of the beam's centre of gravity. A central distribution plate 41 of the beam rests on the beam tie 9. This central plate 41 is passed through by fixing elements 40 firmly connecting the two lateral beam parts 3G, 3D via the central plate 41.

Moreover, the beam tie passage 15 formed by the lateral parts 3G, 3D allows a relative sliding of the beam with respect to the beam tie. Such a characteristic allows the beam 3 to adjust naturally relative to the beam tie 9. This last property of the attachment system proves to be particularly advantageous when the beam 3 is subjected to an asymmetrical load. This is for example the case when equipment such as air-conditioning or heating equipment are fixed supported on the beam at a point distant from the centre of the beam. In such cases, the additional degree of freedom offered by the relative sliding of the beam 3 with respect to the beam tie 9 makes it possible to reduce the potential energy connected with the load stress. Such a property therefore makes it possible to further stabilize the attachment system.

It should however be noted that if in the present embodiment, the beam 3 is supported by the beam tie 9, the latter can also be connected to the beam tie according to various possible variants.

According to one variant, the beam tie can support the beam by means of a ring or an equivalent connecting element allowing the beam 3 to slide along the beam tie.

According to another variant, the beam tie is simply fixed to the beam, for example in the centre of the upper surface of the beam. This variant makes it possible to simplify the production of the attachment system 1. By doing this, an attachment system 1 is obtained in which the stressing of posts by a beam tie compensates at least partially for the moment exerted by the beam 3 on the posts and moreover creates an increase in longitudinal stress in the beam 3. Such an attachment system benefits from great simplicity of assembly, makes it possible to lengthen the span of the beam and to absorb part of the stress force exerted on a post. The fact that the beam tie connects the beam 3 moreover makes it possible to stabilize the beam - posts assembly of the attachment system.

According to another variant, the beam tie can be produced in two distinct beam-tie parts. One of these parts connects a post to the beam and the other one of these parts connects the beam to another post. An anchored-type beam tie - posts -

beam structure is then obtained in which each of the two beam-tie parts compensates at least partially for the moment exerted by the beam on each of the posts.

Moreover, it has been mentioned above that the additional degree of freedom offered by the relative sliding of the beam 3 with respect to the beam tie 9 made it possible to reduce the potential energy connected with the load stress and to further stabilize the attachment system. However, it is possible to limit the relative sliding of the beam with respect to the beam tie, in order to prevent instability of the attachment system. To this end, a sleeve 43 fixed onto the beam tie 9 limits the sliding of the beam with respect to the beam tie. This is better described with reference to Figure 6.

Figure 6 is a partial cross-section, along a longitudinal section of the beam, at the level of its central part. The figure shows the central part of a beam 3 comprising two lateral parts. The cross-section is made between these two lateral parts. The beam tie 9 is engaged in the beam-tie passage form by the lateral beam parts and allows a relative sliding of the beam 3 with respect to the beam tie 9. In one embodiment, illustrated by way of example in Figure 6, the beam 3 and the beam tie 9 are mounted sliding relative to each other according to a finite sliding portion. The slipping portion is delimited by two sleeves 43, 45 fixed onto the beam tie 9. The two lateral beam parts are connected by a central distribution plate 41, with several holes drilled in it allowing the fixing of the plate 41 onto the two lateral parts. The central distribution plate can thus slide along the beam tie 9 and between the sleeves. The difference between the finite sliding portion and the length of the distribution plate defines a sliding play, as illustrated in Figure 6.

According to a variant, the distribution plates 19, 41 are themselves subdivided into two plates. Each of these two plates can be pre-assembled on a lateral beam part 3G, 3D. Thus, the assembly phase of the beam 3 now requires no more than assembly directly by fixing the lateral beam parts, for example by means of bolts. On the other hand, the pre-assembly phase being a factory phase, it can be easily controlled. Any errors during the assembly of the beam are thus eliminated. The on-site assembly of the beam 3 is substantially simplified by this.

The sliding play is typically comprised between $0.2/10{,}000^{th}$ and $5/10{,}000^{th}$ of the span of the beam. This play is chosen so as to be well below an instability threshold of the attachment system, i.e. a threshold beyond which the sliding of the beam 3 threatens the stability of the system. Such a characteristic allows the beam 3, articulated moreover on connecting rods, to be adjusted with respect to the beam tie 9, inside a delimited sliding portion. Thus, when the beam 3 is subjected to an asymmetrical load, the additional degree of freedom provided by the relative sliding of the beam 3 with respect to the beam tie makes it possible to reduce the potential

energy connected to the load stress. Such a property makes it possible to stabilize the attachment system, as described above. However, the sliding takes place inside a finite sliding portion (delimited by sleeves), in order to prevent the beam from sliding beyond the instability threshold of the attachment system.

Figure 7 shows a front view, representing a beam intended to be mounted in the attachment system. The beam 3 is subdivided into three longitudinal segments 31, 32, 33. The third segment 33 is similar to the first segment 31 but oriented symmetrically relative to the central transversal section of the beam 3. Each of the segments ends in a stepped section at least one of its ends, as shown in the figure, so that the assembly of the segments is facilitated. Preferably, the central segment 32 has a stepped section such that it rests on the other two segments 31, 33. Fixing plates 34 consolidate the beam 3 at the level of the stepped sections. Taken separately, these segments 31, 32, 33 are more manoeuvrable than a beam which is all in one piece, which considerably simplifies the logistics relating to the delivery of the attachment system to a site. Moreover, the use of segments makes it possible not to have to resort to exceptional transport means and therefore to reduce the production cost of an assembled beam.

It is possible, as required, to provide as many beam segments as necessary so as not to have to resort to exceptional transport means. Such an attachment system design, according to the invention, makes it possible to envisage the production of beams with lengths ranging from 5 to 120 m. It is, in fact, theoretically possible to produce beams with lengths greater than 120 m in an attachment system according to the invention, by adapting the general dimensions of the beams and posts. Among the lengths of beams typically envisaged in the attachment system according to the invention, the following lengths can be mentioned: 18, 24, 30, 35, 40, 55 and 70 m.

The material used for the beam is glued-laminated material. As a variant, a welded reconstituted steel section can be used.

Typically, the beam tie is made of steel or steel derivative and has a modulus of elasticity comprised between 190,000 and 230,000 MPa.

The invention is not however limited to the variants described above but is capable of numerous other variations easily accessible to a person skilled in the art. For example, it is possible to envisage dividing a beam into any uneven number of longitudinal segments. An uneven number of segments makes it possible to envisage a beam which is symmetrical relative to its central transversal section, the beam comprising a central segment resting on the beam tie. The number of segments can then be optimized so as to reduce the overall cost of mounting the attachment system.